

Biological Nitrate Treatment – Experience and Insights from two Demonstration Studies

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Outline

1. Brief Introduction
2. Configuration of the Biological Denitrification (BDN) System evaluated by WQTS
3. Performance of Biological Treatment System
4. Comparison of Alternatives
 1. Alt. 1: 50 gpm system operated 24 hrs/day
 2. Alt. 2: 125 gpm system operated 10 hrs/day
5. General Observations



Acknowledgement & Disclaimer

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The opinions expressed in this presentation are those of WQTS, and not necessarily those of the City of Glendale, County of Los Angeles, or the Water Research Foundation.



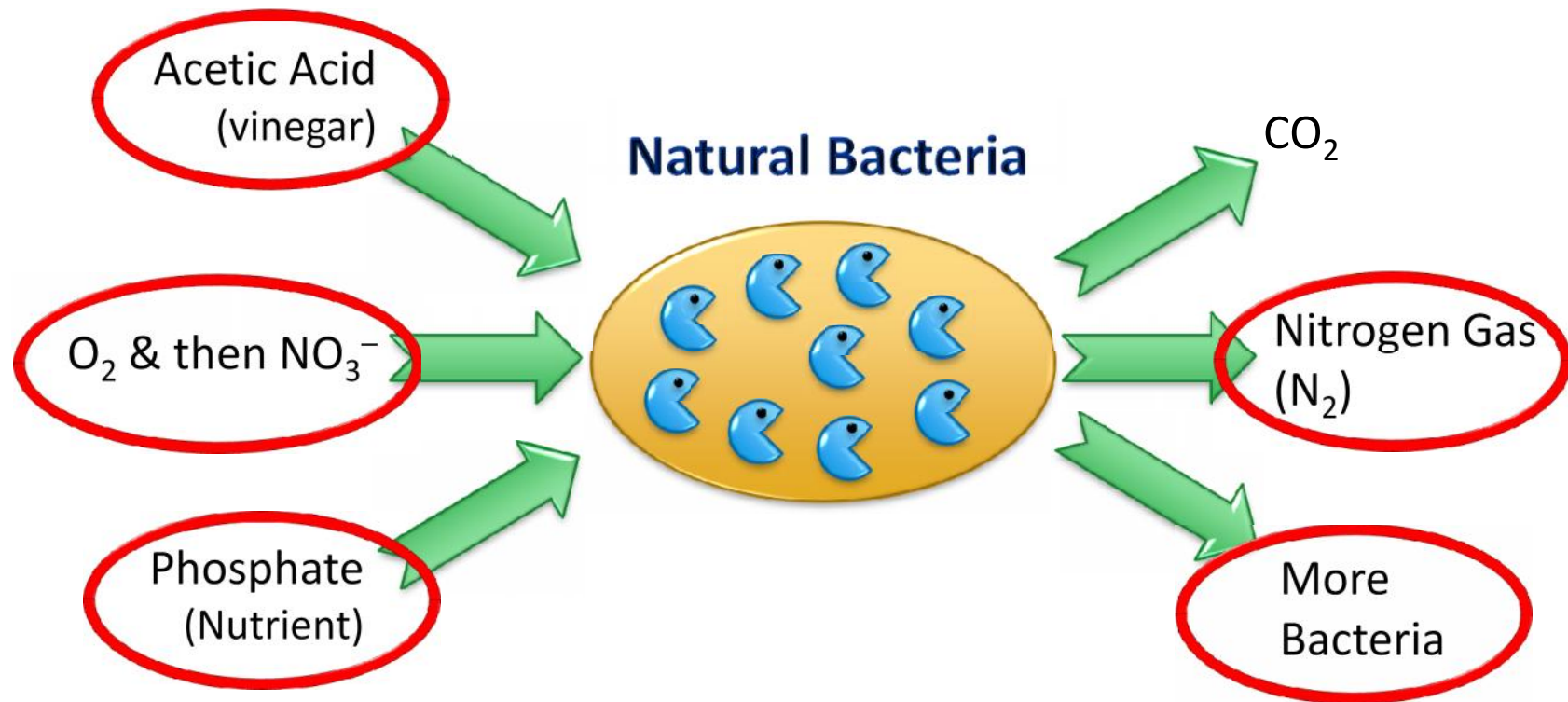
Our Role

- ◆ *WQTS is not a technology provider*
- ◆ *We are an environmental engineering & science consulting company*
- ◆ *Our goal is to evaluate treatment technologies and make recommendations to water agencies*
- ◆ *We have no vested interest in any technology, whether biological, ion exchange, or RO; and no interest in the means of its application (i.e., centralized system or POU)*
- ◆ *WQTS, along with the City of Glendale, received conditional approval from DPH for the BDN treatment system that we evaluated for the City of Glendale*

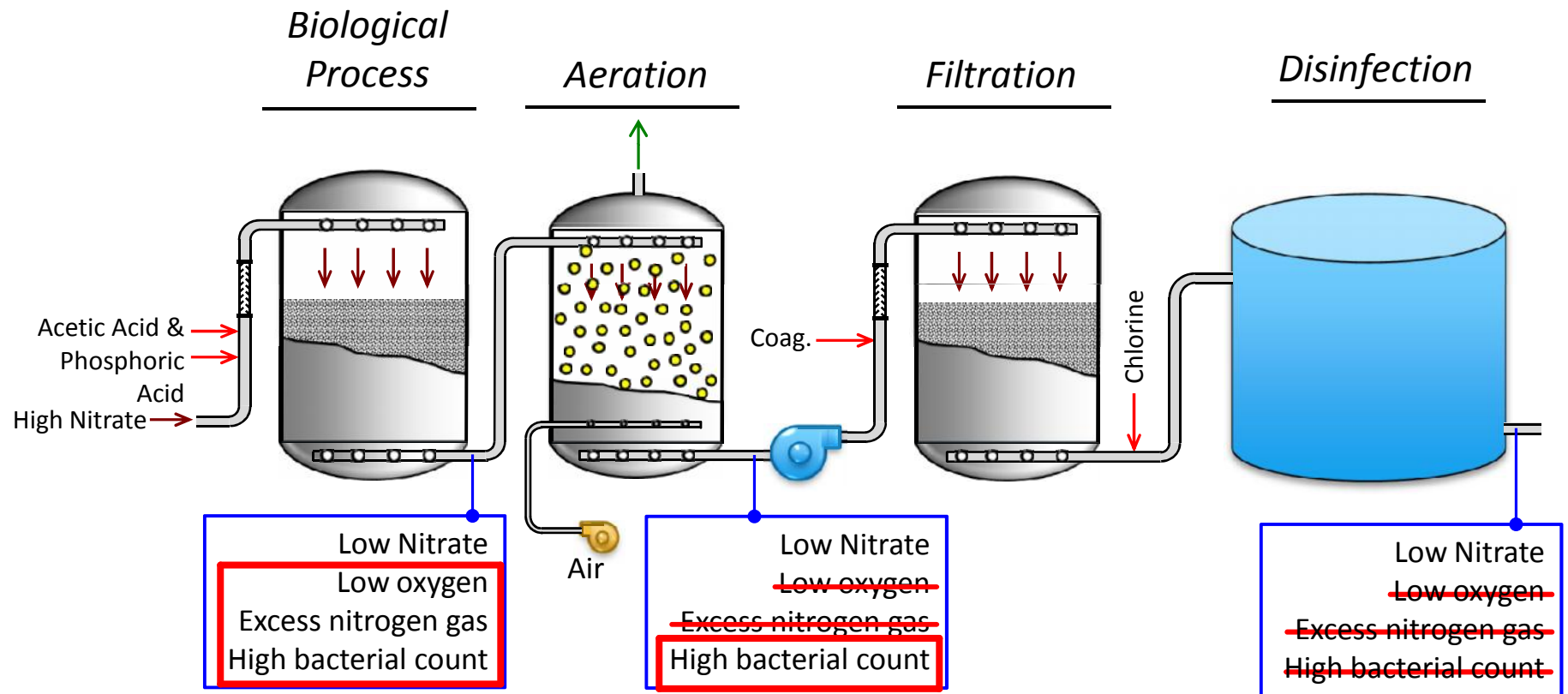


Configuration of a BDN Treatment System

Fundamentals



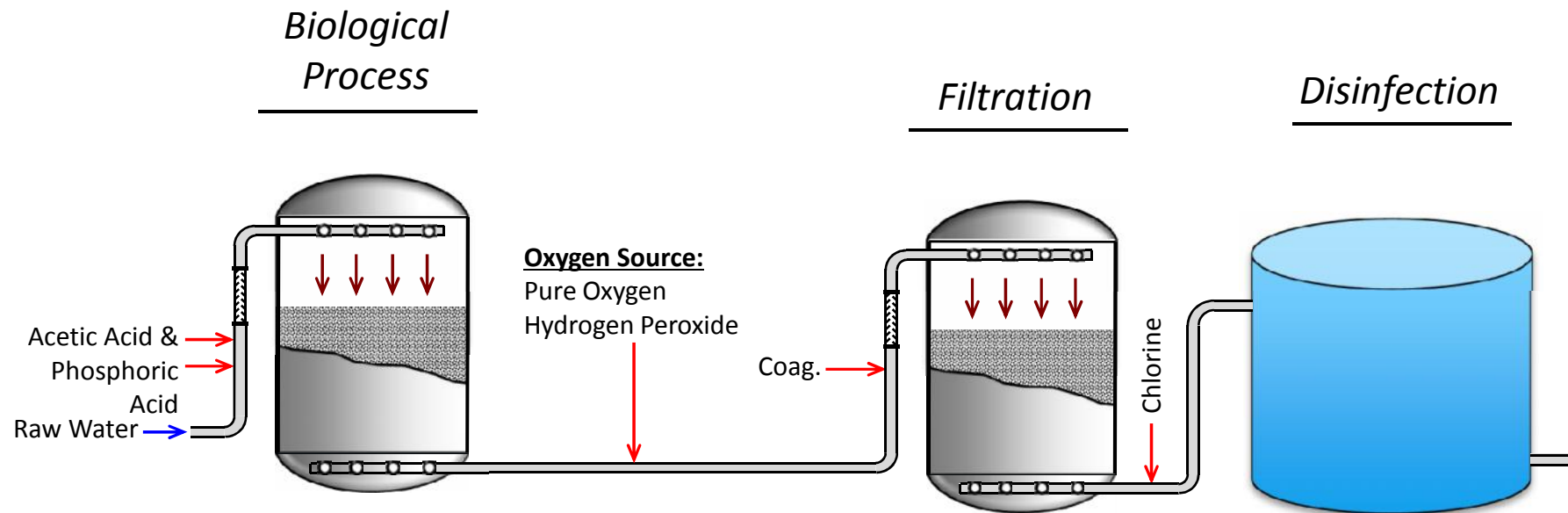
Overall Treatment System



Is Aeration Necessary?

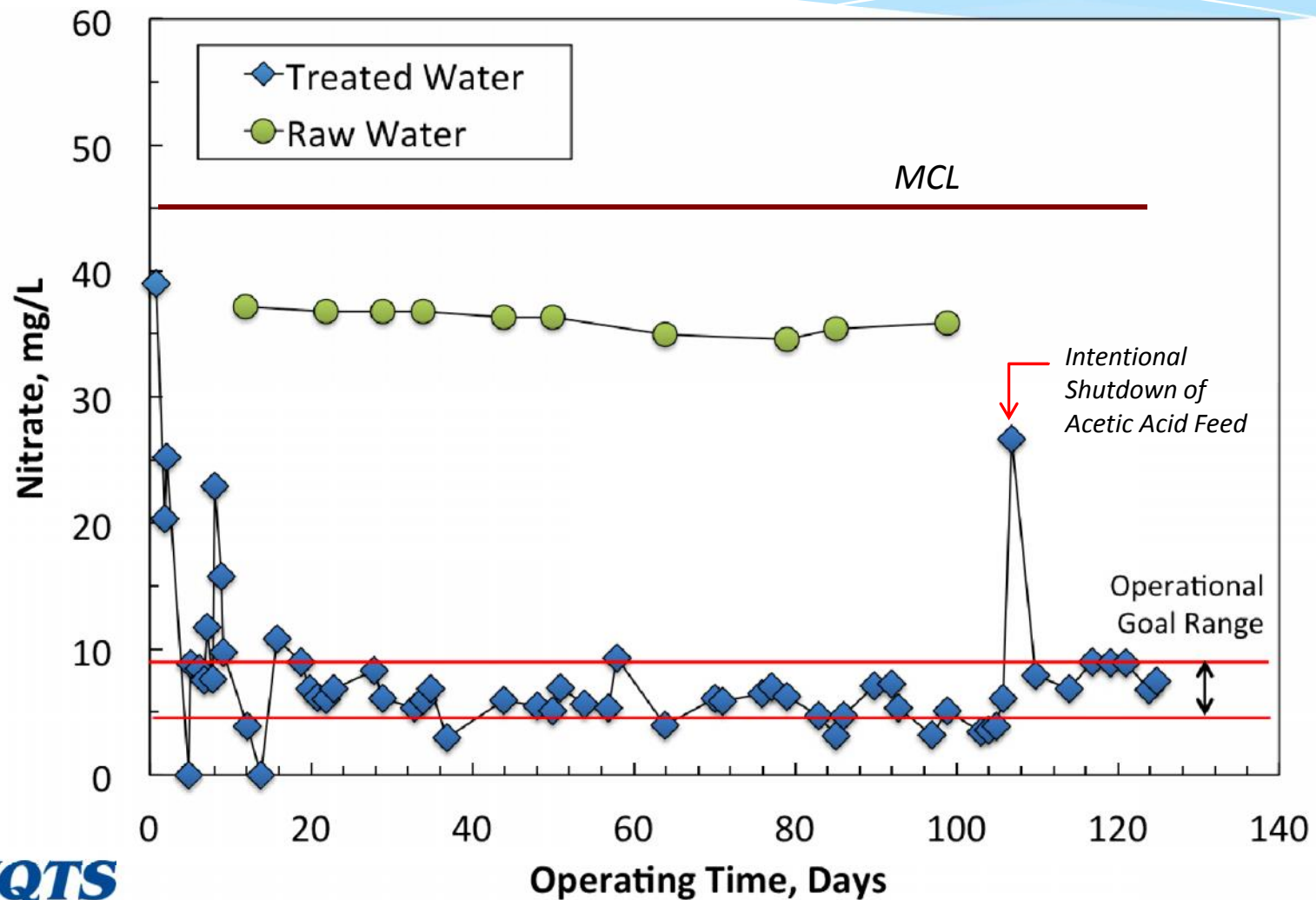
- ◆ *Yes, especially for continuous operation.*
- ◆ *Not just for oxygen addition, but more for nitrogen removal.*
- ◆ *Without it, excess nitrogen causes problems for filter operation & performance.*
- ◆ *These include air-binding, excessive headloss, and turbidity breakthrough.*

For short intermittent operation...

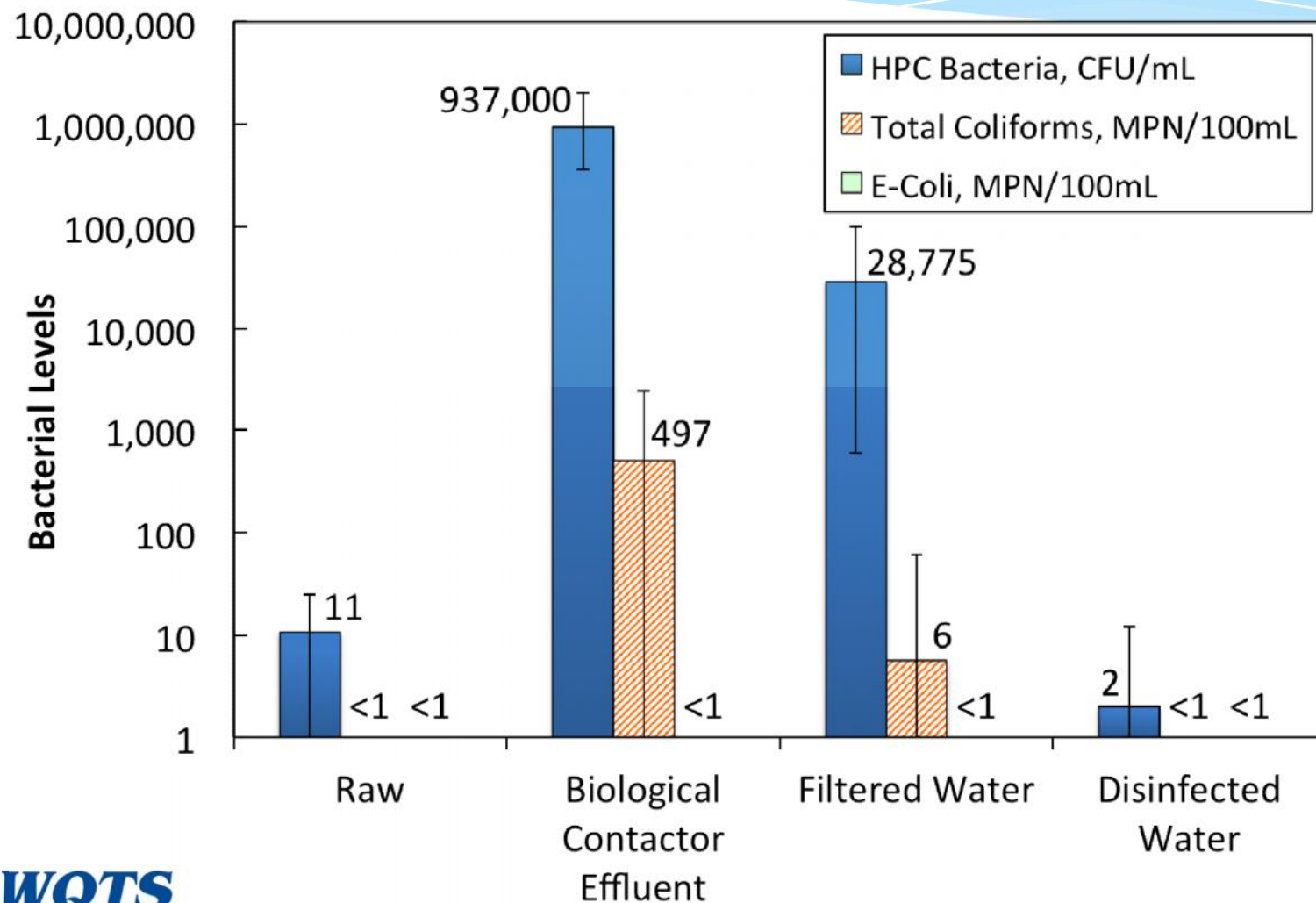


Performance of Biological Treatment System

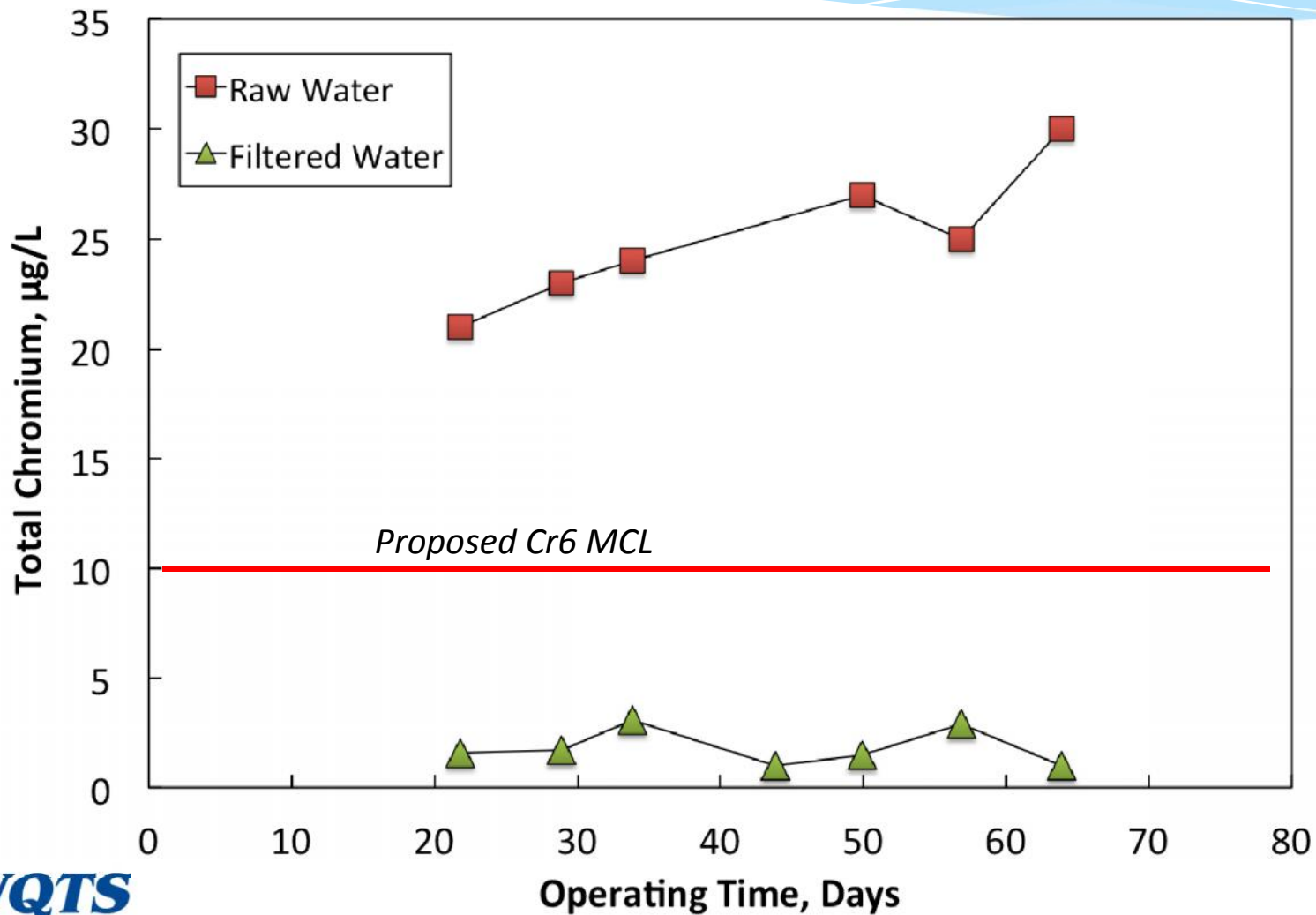
Nitrate Removal



Bacterial Levels



Removal of Chromium



Waste Backwash Water Quality

Parameter	Unit	Value
Nitrate	mg/L	16.4
Nitrite, as N	mg/L	<0.1
Sulfide	mg/L	0.1
Volatile Suspended Solids (VSS)	mg/L	120
Total Suspended Solids (TSS)	mg/L	190
BOD, Total	mg/L	14

Can Waste backwash water be Recovered?

- ◆ *Yes, but not in a small treatment system for several reasons:*
 - ◆ *It adds operational complexity*
 - ◆ *It adds instrumentation cost*
 - ◆ *Could cause aesthetic water quality problems if not operated carefully*
 - ◆ *Could increase backwash frequency, and thus wastage rate*
- ◆ *We do not believe this is a viable option for a small water system*

Online Monitoring

- ◆ *In a large system, online monitoring of the treated water is used for:*

Nitrate; Turbidity; Chlorine; & Oxygen

- ◆ *The instruments required for the above parameters are costly (~\$25,000), and require routine maintenance that is also costly*
- ◆ *They also add a higher level of complexity and demand operator attention and expertise*
- ◆ *How necessary is each for a small system operation?*
- ◆ *Are there less costly alternatives?*

Comparison of Alternatives



Alternatives Considered

Alt. 1: 50 gpm; 24 hrs/day

- Small(er) system requiring smaller vessels
- Continuous operation requires aeration to remove excess nitrogen and allow for smooth filter operation

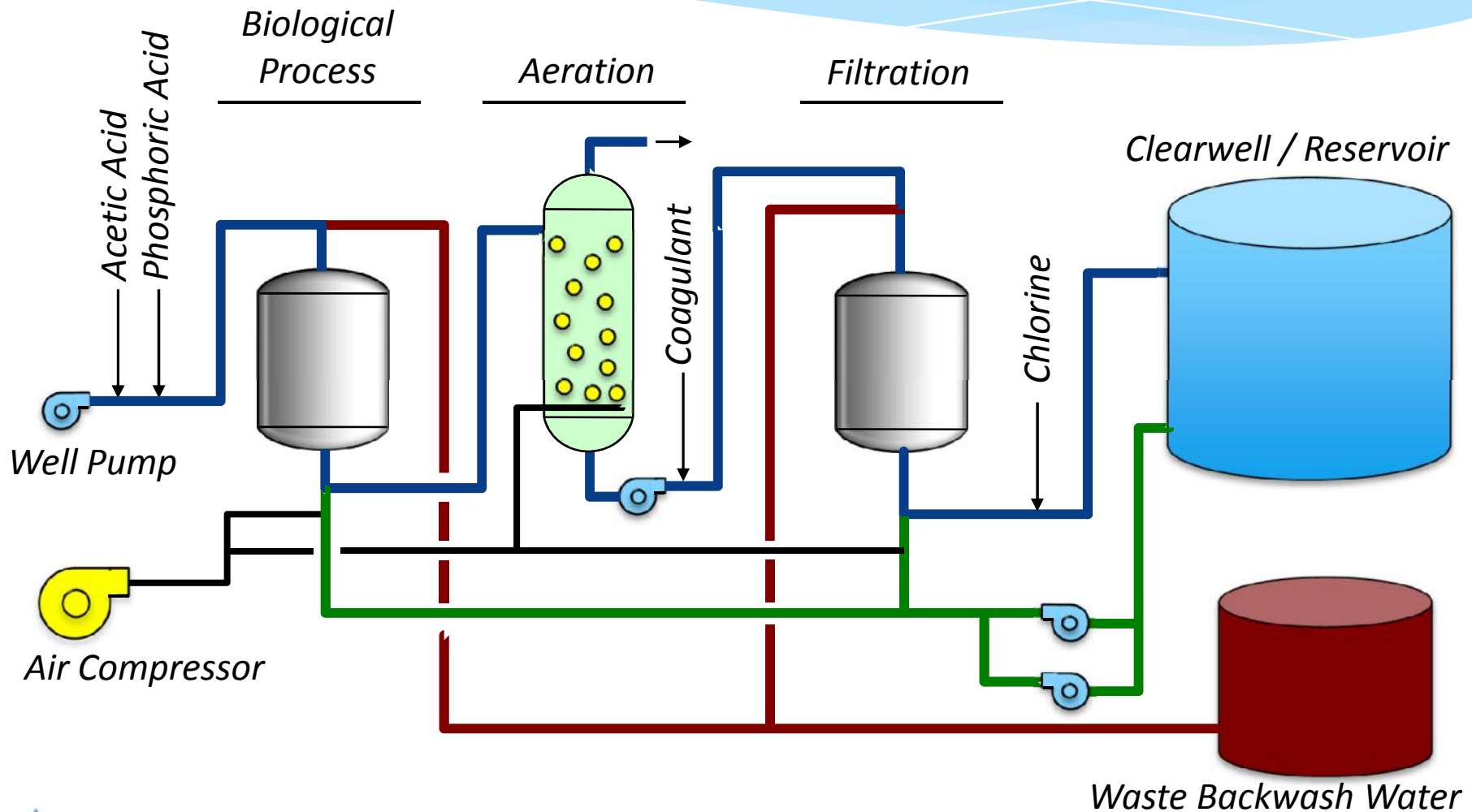
Alt. 2: 125 gpm; 10 hrs/day

- Large(r) system requiring larger vessels
- Short-term operation may allow for operation without aeration
- Oxygen can be replenished with the addition of hydrogen peroxide

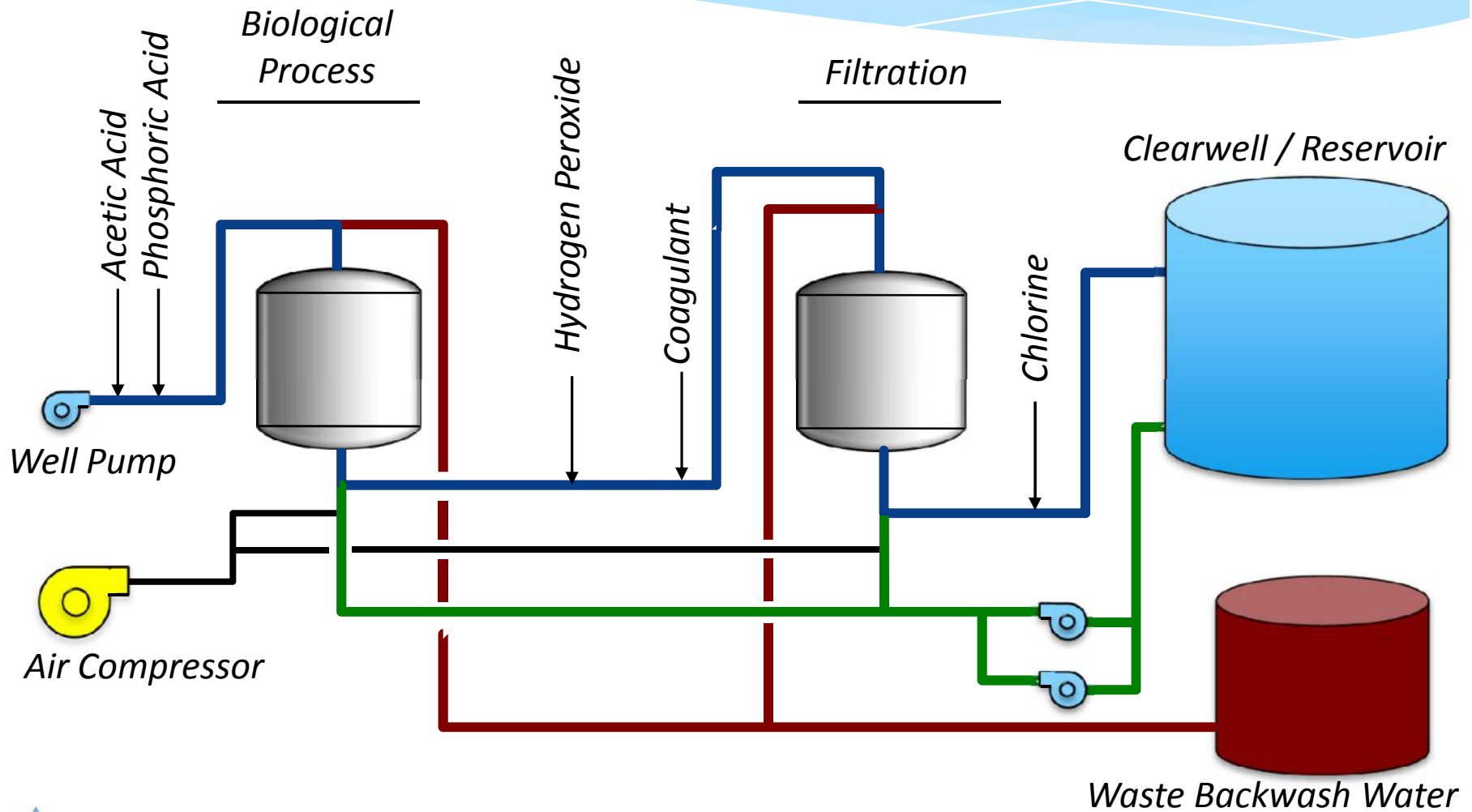
Existing System



Alt. 1 – 50 gpm; 24 hrs/day



Alt. 2 – 125 gpm; 10 hrs/day



Cost Assumptions

- ◆ *Daily production of 72,000 gallons*
- ◆ *Nitrate in groundwater = 60 mg/L*
- ◆ *Target Nitrate = 5 to 10 mg/L*
- ◆ *Alt. 1 – 24 hrs/day operation @ 50 gpm*
- ◆ *Alt. 2 – 10 hrs/day operation @ 125 gpm*
- ◆ *Capital Cost = 2.5 x Equipment Cost*
- ◆ *Space is Available*
- ◆ *Septic system capacity is available*

Design & Operational Assumptions

- ◆ *EBCT of biological contactor = 10 minutes*
- ◆ *Maximum filtration rate = 3.0 gpm/ft²*
- ◆ *Time between backwashes = 24 to 48 hrs*
- ◆ *Backwashing is done daily if system is operated for any portion of the day*
- ◆ *Unit Backwash Volume = 150 gal/ft² for each of biological contactor and filter vessel*

Comparison of Alternatives

Parameter	Alternative 1	Alternative 2
Treatment Size	50 gpm	125 gpm
Operating Schedule	24 hrs/day	10 hrs/day
Vessel Diameter (ea.)	6 ft	8 ft
Volume Generated	72,000 gal/day	72,000 gal/day
Aeration Required?	Yes	No
Equipment Cost	\$200K – \$250K	\$250K – \$300K
Total Cost Factor	2.5	2.5
Total Capital Cost	\$500K – \$625K	\$625K – \$750K
Chemical Cost	\$20K/yr – \$25K/yr	\$20K/yr – \$25K/yr
Wastage Rate	up to 12%	up to 21%
Wastage Volume	up to 8,500 gal/day	up to 15,000 gal/day

General Observations

- ◆ *Biological treatment is highly effective at removing nitrate, Cr6, and other water constituents.*
- ◆ *It generates a waste stream that can be discharged to any septic system.*
- ◆ *However, it is more complex and costly than other treatment systems, such as ion-exchange.*
- ◆ *The higher wastage rate from a larger system operated 10 hrs/day greatly favors a smaller system operated continuously.*
- ◆ *Washwater recovery is viable, but not recommended for small systems because it adds complexity and can cause aesthetic water quality problems.*



Thank You!

Questions?

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Introduction

System
Configuration

System
Performance

Comparison of
Alternatives

General
Observations